National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Exemplar for Internal Assessment Resource

Science Level 1

Resource title: Fiberglass Versus Polystyrene

This exemplar supports assessment against:

Achievement Standard 90943

Investigate the Implication of Heat in Everyday Life

Expected responses

The moderators have developed expected student response from a wide variety of sources.

Date version published by Ministry of Education: December 2010
To support internal assessment from 2011

	Grade Boundary: Low Excellence
1.	A well set out investigation. Data within the range expected. Shows effects of insulation. Well set out conclusion. Report shows good linking with science ideas concerning insulation. Shows insulation slows down heat loss due to conduction. Has mentioned limitations of the experiment, reliability and validity. Has not fully explained why there are gaps in insulating materials. Has both experimental and report data. One only required.

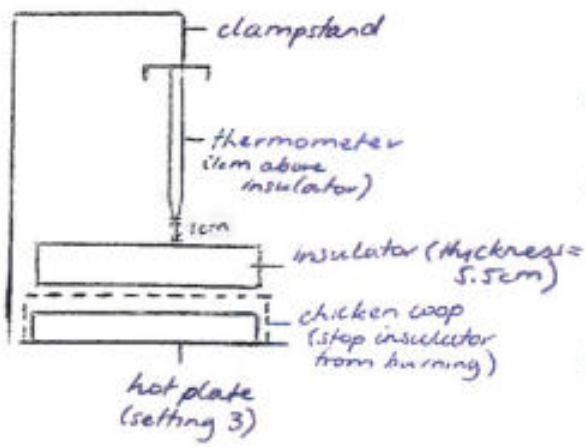
Underfloor insulation

Primary data

Aim: To find out if fibreglass is a better insulator than polystyrene for underfloor insulation.

Hypothesis: Polystyrene will be a better underfloor insulator than fibreglass.

Method:

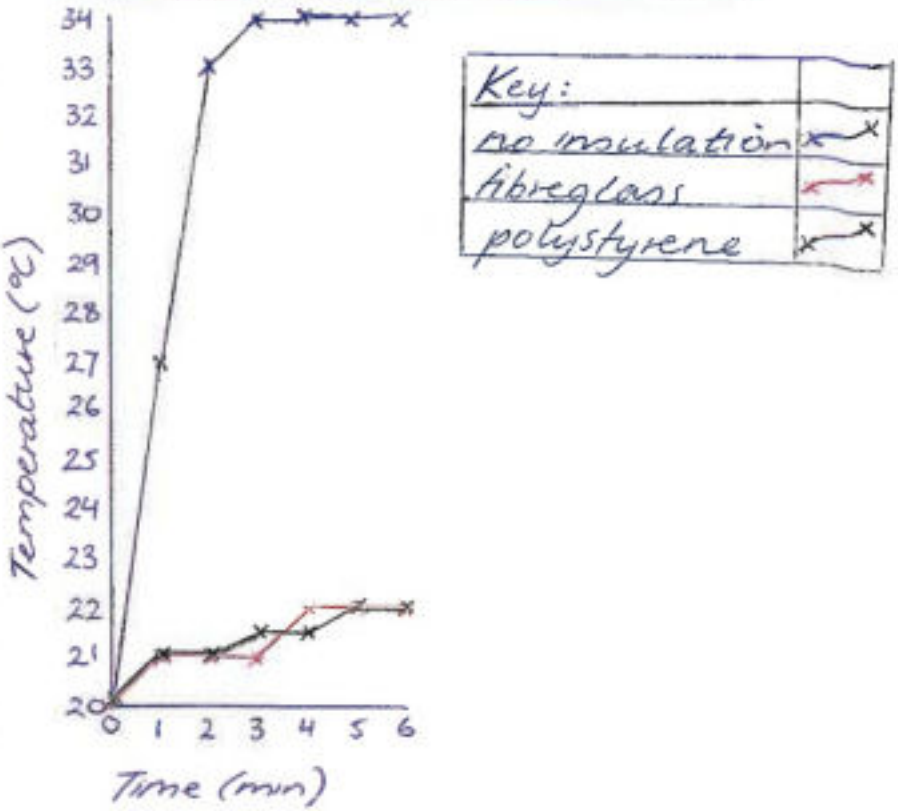


1. Measure starting air temperature.
2. Get equipment set up.
3. Heat hot plate (setting 3) till it is at a steady temp.
4. Take temperature every minute for no insulation (air). Stop recording and heating after 6 minutes.
5. Repeat with the polystyrene and then the fibreglass.

Results

Time (minutes)	Polystyrene	Fibreglass	Air
0	20	20	20
1	21	21	27
2	21	21	33
3	21	21.5	34
4	22	21.5	34
5	22	22	34
6			

Comparison of insulation times



1

Conclusion: Fibreglass and polystyrene are both good insulators compared to air (no insulation) The rate at which heat is transferred through polystyrene and fibreglass is steady and fairly equal.

Science Report

Insufficient insulation is a big issue in New Zealand. Homes that are poorly insulated are cold and damp, and use large amounts of energy to heat up. Two methods of reducing heat loss are to place either fibreglass pads or polystyrene sheets under the house in close proximity to the floor boards. Insulating your home will save energy and provide a healthier and more comfortable indoor environment.

Heat is a form of energy that escapes and enters your home by either conduction or convection.
Conduction is the transfer of energy by the collision of vibrating particles. and convection is the transfer of energy by the movement of particles from one place to another. Heat always flows from a hotter area to a colder area.
An uninsulated house looses a lot of energy:

- 21-31% through the windows
- 12-14% through the floor
- 18-25% through the walls
- 30-35% through the roof
- 6-9% through drafts and air leakage.

So it is wise to insulate your home, through my experiment I found out which was the best underfloor insulator.

An insulator is a bad conductor of heat. Polystyrene and fibreglass are good insulators because they limit air movement by having many cavities within them that traps air. When the air is trapped it

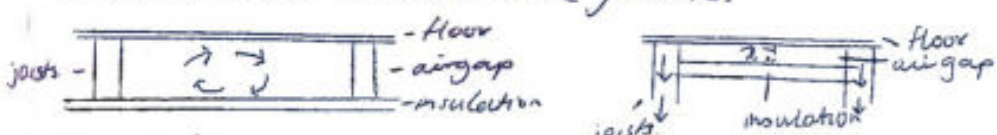
circulates, making all the particles warm. They also have high R-values. R-value indicates the resistance to heat flow. The higher the R-value, the greater the insulating effectiveness. The R-value of thermal insulation depends on the type of material, its thickness, and its density.

The R-value of:

polystyrene - 4.00
fibreglass batt - 3.14
air - 0.68

This means that the polystyrene has the greatest resistance to heat flow. In my experiment I found that there wasn't a great difference between the insulating effectiveness of the ~~be~~ polystyrene and fibreglass, but the polystyrene was more stable and if we had timed/heated it for longer, it would have been a better insulator. There was however a big difference between the insulators (fibreglass and polystyrene) and no insulation (air). Even though air is a good insulator (due to the particles being far apart so they don't collide as often) it needs to be trapped to be more effective. So this shows that it is worthwhile to insulate your home.

If you want to have maximum underfloor insulation you need to place the insulation below the joists.



The left diagram is more effective because you will have an air gap and you will

through conduction
stop the heat from going down through the joists by placing the insulation underneath them.
An air gap is needed because it acts as an insulator and circulates the air around making it warm. An air gap increases the insulators effectiveness.

So, when you are insulating under the floor, polystyrene will have the greatest insulating effect.
Polystyrene is more expensive but is also highly resistant to condensation and mildew. Moisture trapped within insulators will effect the R-value dramatically because water is a good conductor of heat.
Although polystyrene is flammable, you can get flame retardant grades.
Fibreglass can settle or compress and loose its air gaps if not installed properly or exposed to condensation.

So overall polystyrene is better, but they are both really good insulators as there isn't much difference.
The implication of heat loss in New Zealand homes is a big public issue. Installing underfloor insulation will help dramatically, as having no insulation is hopeless. There are many factors that come in to which insulator is the best, but when it comes to insulating effectiveness, polystyrene is better.

Validity / Reliability
My experiment was reliable because it had:
- same starting temperature
- same thickness insulator.

- same temperature hot plate.
- accurate recordings - thermometer.
- thermometer was the same distance from insulator
- . . heated for the same amount of time.
- time recorded after every minute
- same room temperature.

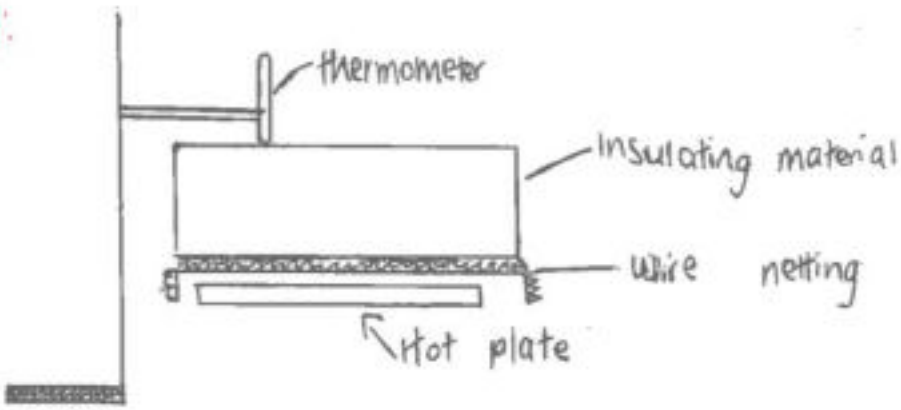
What would I do differently?

I would carry out the experiment for longer than 6 minutes and repeat it to get accurate results.

	Grade Boundary: High Merit
2.	A well set out investigation. Data within the range expected. Shows effects of insulation. Well set out conclusion. Report fails to adequately show links with science ideas concerning insulation. R values well researched but only described. Has mentioned limitations of the experiment, reliability and validity. Has both experimental and report data. One only required.

Aim: To discover whether fibreglass or polystyrene is a better insulator when used for underfloor insulation.

Method:



1. Set up equipment as shown in the diagram
2. Set the hot plate to 2.
3. Record initial temperature
4. Time for 5 minutes. Then record the temperature
5. Repeat experiment 3 times (to give a total of 3 results)
6. Repeat numbers 1-5 with the other type of insulating material.

Results

2

Expol - Polystyrene	TEST 1	Batts - Fibreglass
18°C	Initial Temp.	19°C
18°C	1 min	19°C
18.1°C	2 mins	19°C
18.5°C	3 mins	19°C
19°C	4 mins	19.2°C
19.5°C	5 mins	19.9°C
20°C	6 mins	20°C
	TEST 2	
21°C	Initial Temp.	21°C
21.4°C	1 min	21
22°C	2 mins	21
22.9	3 mins	21
23.5	4 mins	21
24.5	5 mins	21.1
25	6 mins	21.2
	TEST 3	
22°C	Initial Temp.	22°C
22	1 min	22
22.2	2 mins	22
23.1	3 mins	22.3
25	4 mins	23
26	5 mins	23
27	6 mins	23

Report

Polystyrene VS Fibreglass

2

Polystyrene has themal insulation properties that make it a good source of insulation such as it consists of mainly stabilised air. Some long term benefits of polystyrene is that its performance is not affected over time, and can last for more than fifty years. It is not affected by moisture and is not affected by mildew. It will not rot as it is not a moisture barrier so it can breath. It always maintains it's shape, structure cohesion and physical appearance and is specifially designed for underfloor insulation (wooden floors (underfloor insulation). It is a stable, rigid foam that can be cut into shapes and varieds thicknesses. This makes it good for underfloor insulation as it can fit into spaces and the stabilised air means heat has trouble travelling through convection as there aren't enough particles touching each other.

Mineral wools such as fibreglass batts is generally dust free. It is avaliable with and without vapour retarder and with unsanded noise prevention properties. It is less effective if wet, but properties are restored when it dries. It is relatively esy to install and are flexible and fits into little spaces and cracks because it is not a rigid shape. Since it is not a rigid shape and contains many air spaces so heat cannot travel through conduction.

Around 35% of the energy used on average in New Zealand homes is used on heating homes. A cost benefit analysis from October 2006 showed the annual saving in bills from new homes that have been isolated

ranges from $760 - $1,800. How well insulation works depends on the quality of the products, how well they are insulated, and [illegible] what the thermal resistance (r value) is and if it is fit for the person. The insulation under the floor should be at least 50mm thick(unless you have foil) The foil must not be ripped or torn. There shouldn't be gaps between isulation and framing or pieces of insulation. It should cover the entire area including manhole cover. Cost, ease of insulation and preferences about product are factors to be considered by the home owner. The R-value indicates the resistance to heat flow. The more resistance to heat flow (R value) the better the insulator. Individual R-values are added to calculate value of multi-layed insulation.

It is recommed that the r-value of underfloor insulation is R1.4 anywhere in New Zealand. Polystyrene is R=5 to per inch Fibreglass batts R=3.1-4.3per inch. The test I carried out by measuring the temperature of the insulating material that is over a heating plate. The results showed more heat travelled through the expd (polystyrene) in all three tests. This means it is a better conductor of heat and a worse insulator. The batts(fibreglass) showed less heat travelled through it in all three tests, it is a better insulator. This is correct as the batts have a lower R-value meaning they are a better insulator. They are also easier to install due to their properties.

2

EXAMPLES OF PAY BACK:
NEW HOMES TO USE
30 PERCENT LESS ENERGY

New, tougher insulation requirements by the Government will result in new homes using about 30 percent less energy to achieve comfortable indoor air temperatures.

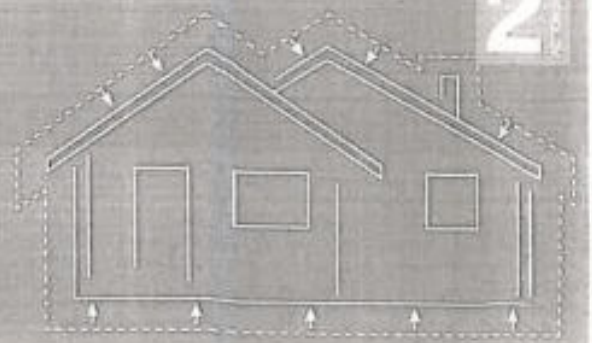
NEW HOMES

Location	Average cost of constructing a medium-sized house now	Average additional cost of construction after the changes	Annual saving in energy bills	Return period on investment (in years)
Auckland	$254,000	+$3,000 to $5,000	$760	7
Wellington	$253,000	+$3,000 to $5,000	$940	6
Christchurch	$251,000	+$3,000 to $5,000	$1,340	4
Dunedin	$250,000	+$3,000 to $5,000	$1,800	3

Note: this assumes the entire home is heated to 18°C all day, and the living areas are heated to 20°C in the morning and evening. While this heating regime is greater than most New Zealanders currently adopt, it is similar to mandated heating regimes in new houses (based on cost benefit analysis from October 2007).

Quality of products
how well they are
insulated
Thermal resistance (r value)
should be fit for purpose.

Make your home warmer and healthier



We all want a warm, comfortable home, but many New Zealand houses are difficult and expensive to heat to healthy temperatures.

Around 35% of the energy used in the average New Zealand household goes on heating your home. If your home doesn't have adequate insulation (like the majority of our homes), a lot of your heat is just wasted.

Improving your home's ability to keep in the heat and smart use of a clean, efficient heating system will make your home more cost-effective to run and warmer and healthier to live in.

Insulation

Good insulation makes a big difference to a home's warmth, comfort and health. Unfortunately, nearly 60% of New Zealand's homes have inadequate ceiling and underfloor insulation.

Many homes built before insulation became mandatory in 1978 have no insulation at all. In other cases the insulation may have been in place for years and is either not working properly anymore or is well below today's standards.

Either way, there is a good chance your home could benefit from more insulation.

Check your insulation

It should be fairly straightforward to check insulation in your ceiling and underfloor, and if you are renovating you can check your wall cavities.

If there is some existing insulation, check for the following:

- Is it dry? The effectiveness of insulation is greatly reduced when it is damp. If it is not dry, repair the source of the dampness and remove and replace the insulation.

EECA energywise
THE POWER TO CHOOSE

2

Research Question: Discuss the relative insulation ability of each material

Source	Information	Key Words	In your own words
[illegible]	- Polystyrene insulation has excellent thermal insulation properties essentially because it consists of mainly stabilised air - will not rot and is highly resistant to mildew. - Suffers little or no effect from water - Always maintains its shape, structure cohesion and physical appearance		

- Is it thick enough? You should have a minimum insulation thickness of 120mm in your ceiling and 50mm under your floor (unless you have foil) – if it's less, add another layer. If you have underfloor foil, check that it is not torn, tarnished or otherwise deteriorated.
- Is it gap-free? Even very small gaps can impact on the performance of your insulation. There should be no gaps between the insulation and framing, or between pieces of insulation, and no tucks or folds.
- Does it cover the whole area? Your insulation should cover the entire area, including the manhole cover, except for areas above/under the eaves, porches or garages.
- Do you have the right clearances around downlights, chimneys and flues? For safety reasons there needs to be a 150mm gap between your downlights or metal flues, and a 50mm gap around brick chimneys. If your insulation has moved or blown around, reposition it.

Ceiling and underfloor insulation first

If you have no insulation, your ceiling should be first priority as this is where most of your heat will be lost. Then insulate under your floor – if the floor is cold, you feel cold.

If you already have some ceiling insulation, insulate your floor before topping up the ceiling if it needs it.

Wall insulation is relatively difficult to install in an existing home as the wall lining or cladding needs to be removed to do it. During renovations is a good time to tackle your wall insulation.

Insulation products

There are various insulation products on the market. They come in different forms, such as blanket products that roll over joists and segments that fit between joists, and are made from different materials including fiberglass, polyester, wool, mineral wool and expanded polystyrene.

Cost, ease of installation in your home, and preferences around product material (e.g. natural versus synthetic fibres) are all things to consider when choosing your insulation.

Whatever type of insulation you are considering, you should only use products tested to the AS/NZS4859.1 Standard – it means you can count on them performing as they say they do. Look for the statement of compliance with the Standard on the insulation packaging or label.

Talk to your insulation supplier or visit **www.energywise.govt.nz** for more information.

Work out what R-value you need

The effectiveness of insulation is measured by its R-value. The higher the R-value, the more it slows down heat transfer.

Always use R-values, rather than thickness, to compare different products so you are comparing like with like.

The R-value you need depends on how cold it gets where you live. The table following gives recommended minimum R-values for existing homes (the Building Code Acceptable Solution H1/AS1 specifies minimum requirements for new homes), but it is a good idea to install more if you can.

Minimum recommended insulation R-values for existing homes

	North Island, excluding the Central Plateau	South Island and the Central Plateau
Ceilings with less than 75 mm of existing insulation	R2.8 blanket insulation or R3.4 segment products	R3.2 blanket insulation or R4.0 segment insulation
Ceilings with 75 mm to 120 mm of existing insulation	R1.8 blanket insulation	R2.4 blanket insulation
Underfloor	R1.4 anywhere in New Zealand	
Walls	Check the thickness of your wall cavity and find the highest R-value product at that thickness	

Good installation is key

Quality of installation is just as important as the insulation product you use. Even small gaps can halve the performance of the insulation.

EECA recommends using a professional to install your insulation for you. As with any service, you should shop around for a few quotes to make sure you're getting the right solution for your needs.

Whether you do it yourself or get a professional, make sure the installation is done properly and safely. Standards New Zealand has a comprehensive easy-to-use guide on installing insulation NZ4246:2006 and it's really worth ensuring that this is being followed. You can download this for free from **www.energywise.govt.nz** (search for "4246").

Other ways to reduce heat loss

There are several other things you can do to reduce heat loss in your home.

Check for air leakage and draughts

If your house is draughty, any insulation you install won't be able to do its job properly. It's important to minimise the amount of air leakage from your house at the same time as you improve the insulation. Common places where draughts occur are around doors, windows, skylights, fireplaces and around plumbing penetrations.

Get good curtains

Hang full-length lined curtains of good quality thermal or close woven fabrics. A pelmet will reduce heat loss further. Drawing your curtains at sunset will help keep the heat in as the temperature cools outside.

Consider double-glazing

Double-glazing can halve the energy loss through windows, and lessen condensation and external noise. It is relatively expensive to install but it is worth considering, particularly when your windows need replacing or when renovating.

Consider replacing your downlights

A safety clearance of 150 mm is necessary between insulation and standard downlights, which reduces the effectiveness of the insulation. If you have standard downlights, consider replacing them with CA-rated models that allow insulation to be lifted right up to them, or with non-downlight fittings that don't require a hole in your ceiling and in your insulation.

Tackle dampness at the source

In most homes insulation alone won't fix dampness problems. If the area under your house is damp, fix any drainage or plumbing issues, make sure it's properly ventilated, and look at installing damp-proof sheeting under the house. Make sure externally vented extractor fans are used in areas of the home that produce a lot of moisture – like kitchens, bathrooms and laundries – are adequately vented.

2

Research Question: Theoretical description of how the physical properties of materials affect their ability to insulate

Source	Information	Key Words	In your own words
Wiki: Summary [illegible] insulating materials	Polystyrene-stable, rigid foam that can be cut into shapes and thicknesses Available as extruded or expanded. Mineral wools - glass-less effective if wet		

2

Research Question: Link the data you have gathered to a scientific theory (provide scientific reasons why one material was a more efficient insulator than the other			
Source	**Information**	**Key Words**	**In your own words**
http://www.ornl.gov/sci/roofs+walls/insulation/ins_02.html	R-value, which indicates the resistance to heat flow. ***The higher the R-value, the greater the insulating effectiveness.*** The R-value of thermal insulation depends on the type of material, its thickness, and its density. In calculating the R-value of a multi-layered installation, the R-values of the individual layers are added.	R-value	The more resistance to heat flow (R-Value) the better the insulator. Individual R-values are added to calculate value of multi-layered insulation.

Discuss relative insulation ability of each material

- **EXPOL** – is non-allergenic and non-irritating
- **EXPOL** – Insulation performance is not affected by ageing
- **EXPOL** – does not itch or release nasty fibres
- **EXPOL** – is flame retardant – will not support the spread of flame
- **EXPOL** – provides wire guard to separate between electrical cables
- **EXPOL** – Fumes given off are less toxic than burning timber
- **EXPOL** – if installed correctly – will last for more than 50 years
- **EXPOL** – is not affected by moisture
- **EXPOL** – is not a moisture barrier – it breathes
- **EXPOL** – recycles all polystyrene waste
- **EXPOL** – comes in 4 standard widths and is available in most Hardware Merchants
- **EXPOL** – complies to the New Zealand Insulation Standard
- **EXPOL** – reduces heating costs and keeps your floor warm
- **EXPOL** – has installation instructions on every bag
- **EXPOL** – is specifically designed for under wooden floors

2

http://www.expol.co.nz/

Expol - polystyrene

	Grade Boundary: Low Merit
3.	Experimental data not there. Data within the range expected. Shows effects of insulation. Report shows good linking with science ideas concerning insulation. Shows insulation slows down heat loss due to conduction. Has described the role of the R values. Has not fully explained why there are different R values. High M on report. Only one required: report or experimental data.

Fibreglass versus Polystyrene

To begin with we need to find out how to determine the best type of insulation. This is done by finding out the materials 'R Value'. The higher the R Value, the greater the insulating effectiveness. The R value of the insulating material depends on the density of the material, its thickness and the material itself The higher R value the more the material slows down the transfer of heat.

Now, you may be thinking, what are the benefits of insulating your home? Insulating your home means there will a reduction in the rate of heat loss in your home. Reducing this makes your house easier and cheaper to heat. This means that your house will be more comfortable and better for you to live in.

So now I have informed you of such things to do with insulation in your home, we shall discuss how heat is lost from the inside of your house. This happens in two main ways.

Air infilteration: This is where hot air escapes from the house due to cracks, gaps, holes and even open chimneys. This previous hot air is replaced by cold air.

Conductivity= This is where hot air escapes directly through walls, ceilings, floors, windows and doors.

Heat always finds the quickest and easiest way out of a house. This means that to get the best results you have to increse the amount of insulation for all of the outside elements of your house.

So you have decided to insulate your home, and your stuck between using fibreglass or Polystyrene.

Polystyrene: Provides full coverage with few heat loss paths and normally provide a higher R Value. Rigid insulation is often used for foundations such as wall sheathing.

fibreglass: Must be hand-cut and trimmed to fit. They can be installed by either homeowners or professionals. They are flame resistant.

My results have lead me to the conclusion that fibreglass is a better insulator. This is because it has a lower average change in heat temperature. Therefore it has

a higher R Value.
When you look for an insulating material you look the material with the highest R value and best thermal resistance.

Source	Information	Words
http://www.ornl.gov/sci/roofs+walls/insulation/ins_02.html	**What Is an R-Value?** **Insulation is rated in terms of thermal resistance, called R-value, which indicates the resistance to heat flow.** The higher the R-value, the greater the insulating effectiveness. **The R-value of thermal insulation depends on the type of material, its thickness, and its density. In calculating the R-value of a multi-layered installation, the R-values of the individual layers are added.**	3
	What type is best? Rigid insulation is made from fibrous materials or plastic foams and is produced in board-like forms and molded pipe coverings. These provide full coverage with few heat loss paths and are often able to provide a greater R-value where space is limited. Such boards may be faced with a reflective foil that reduces heat flow when next to an air space. Rigid insulation is often used for foundations and as an insulative wall sheathing. Blankets, in the form of batts or rolls, are flexible products made from mineral fibers, including fiberglass or rock wool. They are available in widths suited to standard spacings of wall studs and attic or floor joists. They must be hand-cut and trimmed to fit wherever the joist spacing is non-standard (such as near windows, doors, or corners), or where there are obstructions in the walls (such as wires, electrical outlet boxes, or pipes). Batts can be installed by homeowners or professionals. They are available with or without vapor-retarder facings. Batts with a special flame-resistant facing are available in various widths for basement walls where the insulation will be left exposed.	
http://www.energywise.govt.nz/yourhome/insulation/#types	**Effectiveness of insulation** Three key factors determine how well insulation works in your house: • Thermal resistance (r value) of the product installed - the product should be fit for purpose • Quality of the insulation products • How well the insulation is installed in your house.	

R value

3

The effectiveness of insulation is measured by its thermal resistance, or R value. The higher the R value on an insulation product, the more it slows down the transfer of heat. For a fixed insulation density, the R value of insulation gets higher as the product gets thicker.

For example an R3.0 product has greater thickness than a R1.0 product of the same type.

Be careful not to use the thickness of insulation to compare different products, always use the R-values, that way you are comparing like for like.

Note: Reflective foils do not have an R value. The foil helps increase the R value of your floor by trapping air between the floor joists.

Benefits of insulation in your home

Good insulation means a significant reduction in the rate of heat loss in your house via ceilings, walls, floors, windows and doors. This reduced rate of heat loss makes the house easier and cheaper to heat properly. This means the house will be healthier and more comfortable to live in.

Heat loss in the home

Heat is lost from the inside of the house in two main ways:

- Air infiltration - hot air escapes from the house through cracks, gaps, holes, and open chimneys. This is replaced by cold air.
- Conductivity - hot air escapes directly through the elements of the house such as walls, ceilings, floors, windows, skylights and doors.

If your house is draughty, any insulation you install won't be able to do its job properly. It's important to minimise the amount of air leakage from your house at the same time as you improve the insulation.

Heat always finds the easiest path out of a house. If you insulate one part of your house, the ceiling for example, you reduce the rate at which heat is lost through the ceiling. But the rate at which it escapes through other parts of the house increases. To get best results you need increase the insulation for all of the outside building elements of your house.

1

	Expol	Fibreglass
Initial Temp	~~17°C~~ / 18°C!	-19°C
1min	-18°C	-19°C
2min	-18.1°C	-19°C
3mins	-18.5°C	-19°C
4mins	19°C	-19.2°C
5mins	19.5°C	-19.9°C
6mins	20°C	-20°C

3

2.

Room	21°C	Initial	22°C
1min	21.4°C		21°C
2min	22°C		21°C
	22.9°C	3min.	21°C
	23.5°C	4mins.	21°C
	24.2°C	5mins.	21.1°C
	25°C	6mins.	21.2°C.

	Initial Temp.	
22°C		22°C
22°C.	1min	22°C
22.2°C	2min	22°C
23.1°C	3min.	22.3°C
25°C	4min	23°C.
26°C	5min	23°C
27°C	6min	23°C

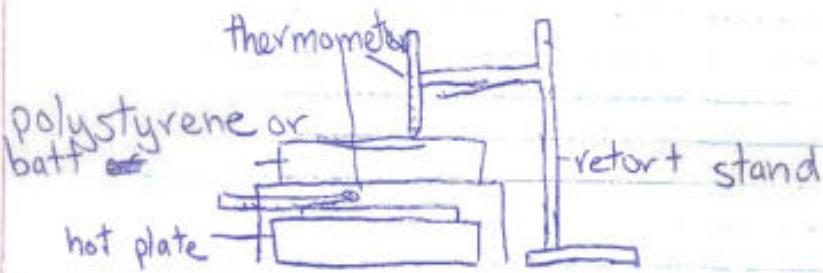
Average heat change of

Expol - 7.7°C Bolts - 0.7°C

	Grade Boundary: High Achieved
4.	A well set out investigation. Data not well explained though graph shows valid trend. Well set out conclusion. Report is included but it is not clear where the information came from. Has mentioned heat transfer but has not said how insulators influence this. Links to science not fully explained. Some of the report does explain R values therefore a High Achieved.

Aim: To see whether batts or polystyrene is a better insulator.

Method:



1. Collect a hot plate, mesh stand, retort stand, thermometer, polystyrene, stop watch and batts.
2. Set hot plate to 2 and place one of the insulators on top of the mesh stand. Measure the room temperature.
3. Leave the insulator above the hot plate for 5 minutes while measuring the temperature above the insulator and in between the hot plate and the insulator.
4. Test both insulators 3 times for 5 minutes each test
5. Record results and graph.

Results:

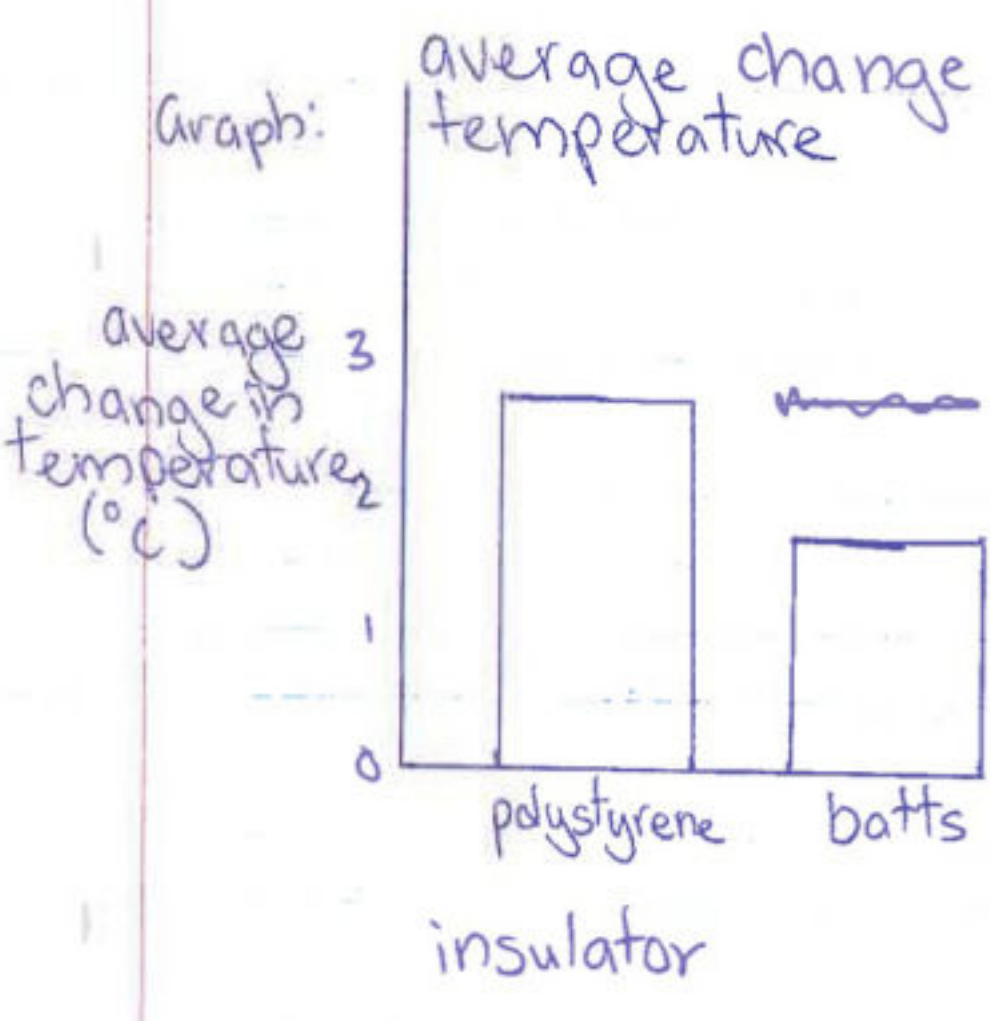
	Polystyrene		Batts	
	start	finish	start	finish
Test 1	18°C	21°C	18°C	20°C
Test 2	18°C	22°C	18°C	21°C
Test 3	18°C	22°C	18°C	21°C
Average	18°C	21.67°C	18°C	20.67°C

Results continued:
The temperature in between the hot plate and the insulator remained at 70°c.

Report:

The results conclude that batts was a better insulator. This means batts prevented the most amount of heat transfer. Heat transfer occurs in three different ways; these are convection, conduction and radiation. ~~Thermal resistance~~ Insulation is rated in terms of thermal resistance, these are called R-values. R-value tells you how much resistance to heat flow the insulator has. The higher the R-value the higher the thermal resistance. i.e. An insulator that has an R-value of 5 has a better resistance to the flow of heat than an insulator that has the R-value of 3. Batts is made of fibres and works similarly to a jersey. Usually the thicker the product the more effective it is. Batts is a good insulator because it traps warm air in air pockets which stops the heat from escaping. Polystyrene is a poor conductor so therefore it is a very good insulator. There are also many other types of insulation, these include; foil which ~~are barr~~ is a barrier against convection and radiation heat transfer and loose fill. Polystyrene is scientifically better because it ~~protect~~ protect against convection, conduction and radiation because it is white so it reflects electromagnetic waves better than batts. Batts only prevent heat flow through convectional and conduction aspects.

Graph:


average change in temperature
4
average change in temperature (°C)
3
2
1
0
polystyrene
batts
insulator

There are three different types of underfloor insulation. Foil types (work on reflection), fibre types and polystyrene types (these two work on the principle of mass, that is trapped air). The different products bring different qualities to your home.

Foil Types

Foil insulation works as a convectional and radiant barrier. It has been difficult to get the best performance out of traditional foils due to building construction methods and strength of products, however newer more advanced types on the market offer some fantastic performance features. The primary advantage of foil is that it acts as a complete vapour barrier stopping rising dampness coming into the home and they are also great for working in tighter areas. Foils are installed in blanket format making them quick and easy to install but there is risk of electrocution in using them so please read and watch the installation instructions carefully.

Fibre types

Fibre forms of insulation work in much the same way as a jersey you wear. Generally the thicker the product the better in works. The most popular form of fibre underfloor insulation is polyester. The key advantage of fibre types of insulation is that they allow the floor to 'breath' while still offering excellent thermal qualities. Precut products are available for fitting between your joists or alternatively blanket format is also available for attaching underneath the joists. They are not particulary suitable for high wind zones or where you have a rising dampness issue but they do offer very good performance and very long life.

Polystyrene

Polystyrene Underfloor insulation is a well known product on the market. It works in your home just like it does as a coffee cup or chilly bin. There are different forms of polystrene products available on the market, each with a small differences. We prefer Retrotherm as it is the more simple and effective products to install. Polystyrene is great for dampening sound reverberation in wooden floor boards and also acts as a partial vapour barrier. Available in wide variety of widths (360mm, 410mm, 440mm, 470mm and 560mm) it is always installed between your joists and each piece is cut to size and friction fit up in place.

What Is an R-Value?

Insulation is rated in terms of thermal resistance, called R-value, which indicates the resistance to heat flow. The higher the R-value, the greater the insulating effectiveness. The R-value of thermal insulation depends on the type of material, its thickness, and its density. In calculating the R-value of a multi-layered installation, the R-values of the individual layers are added.

Insulation Product Types

Some types of insulation require professional installation, and others you can install yourself. You should consider the several forms of insulation available, their R-values, and the thickness needed. The type of insulation you use will be determined by the nature of the spaces in the house that you plan to insulate. For example, since you cannot conveniently "pour" insulation into an overhead space, blankets, spray-foam, board products, or reflective systems are used between the joists of an unfinished basement celling. The most economical way to fill closed cavities in finished walls is with blown-in insulation applied with pneumatic equipment or with sprayed-in-place foam insulation.

The different forms of insulation can be used together. For example, you can add batt or roll insulation over loose-fill insulation, or vice-versa. Usually, material of higher density (weight

per unit volume) should not be placed on top of lower density insulation that is easily compressed. Doing so will reduce the thickness of the material underneath and thereby lower its R-value. There is one exception to this general rule: When attic temperatures drop below 0°F, some low-density, fiberglass, loose-fill insulation installations may allow air to circulate between the top of your ceiling and the attic, decreasing the effectiveness of the insulation. You can eliminate this air circulation by covering the low-density, loose-fill insulation with a blanket insulation product or with a higher density loose-fill insulation.

Blankets, in the form of batts or rolls, are flexible products made from mineral fibers, including fiberglass or rock wool. They are available in widths suited to standard spacings of wall studs and attic or floor joists. They must be hand-cut and trimmed to fit wherever the joist spacing is non-standard (such as near windows, doors, or corners), or where there are obstructions in the walls (such as wires, electrical outlet boxes, or pipes). Batts can be installed by homeowners or professionals. They are available with or without vapor-retarder facings. Batts with a special flame-resistant facing are available in various widths for basement walls where the insulation will be left exposed.

Blown-in loose-fill insulation includes cellulose, fiberglass, or rock wool in the form of loose fibers or fiber pellets that are blown using pneumatic equipment, usually by professional installers. This form of insulation can be used in wall cavities. It is also appropriate for unfinished attic floors, for irregularly shaped areas, and for filling in around obstructions.

In the open wall cavities of a new house, cellulose and fiberglass fibers can also be sprayed after mixing the fibers with an adhesive or foam to make them resistant to settling.

Foam insulation can be applied by a professional using special equipment to meter, mix, and spray the foam into place. Polyisocyanurate and polyurethane foam insulation can be produced in two forms: open-cell and closed-cell. In general, open-celled foam allows water vapor to move through the material more easily than closed-cell foam. However, open-celled foams usually have a lower R-value for a given thickness compared to closed-cell foams. So, some of the closed-cell foams are able to provide a greater R-value where space is limited.

Rigid insulation is made from fibrous materials or plastic foams and is produced in board-like forms and molded pipe coverings. These provide full coverage with few heat loss paths and are often able to provide a greater R-value where space is limited. Such boards may be faced with a reflective foil that reduces heat flow when next to an air space. Rigid insulation is often used for foundations and as an insulative wall sheathing.

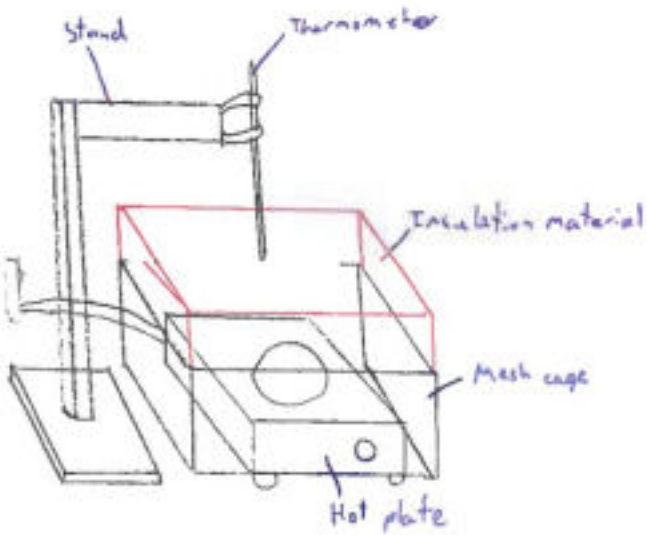
Reflective insulation systems are fabricated from aluminum foils with a variety of backings such as kraft paper, plastic film, polyethylene bubbles, or cardboard. The resistance to heat flow depends on the heat flow direction, and this type of insulation is most effective in reducing downward heat flow. Reflective systems are typically located between roof rafters, floor joists, or wall studs. If a single reflective surface is used alone and faces an open space, such as an attic, it is called a radiant barrier.

Radiant barriers are installed in buildings to reduce summer heat gain and winter heat loss. In new buildings, you can select foil-faced wood products for your roof sheathing (installed with the foil facing down into the attic) or other locations to provide the radiant barrier as an integral part of the structure. For existing buildings, the radiant barrier is typically fastened across the bottom of joists, as shown in this drawing. All radiant barriers must have a low emittance (0.1 or less) and high reflectance (0.9 or more).

	Grade Boundary: Low Achieved
5.	A poorly set out investigation would be hard for a student to replicate. Data not well explained. Graph meaningless but does follow data collected. Well set out conclusion. Report is included but it is not clear where the information came from. Has mentioned heat transfer but has not said how insulators influence this. Links to science not fully explained. Some of the report does explain R values but overall a Low Achieve.

Aim: To discover whether fibreglass or polystyrene is a better insulator when used for insulation under the floor.

Method:



5

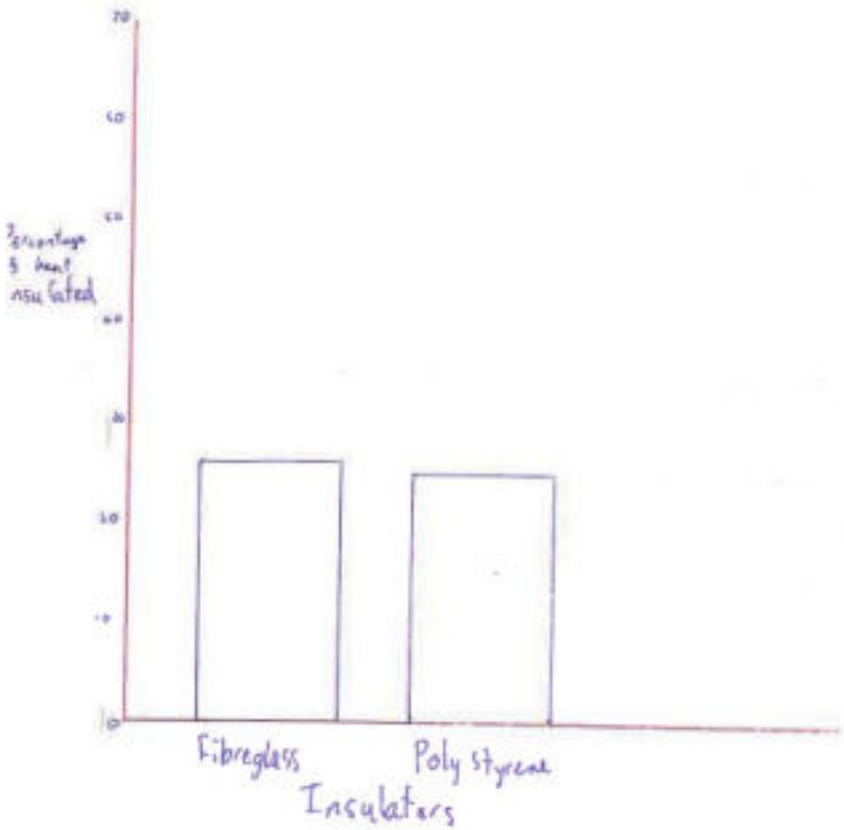
1. Set up gear as shown in diagram
2. Set the hot plate to three
3. Time experiment for ~~three~~ five minutes and repeat three times
4. Do the same for other insulation material
5. Record results. (temperature of insulation material)

Results: 5 minute tests

Insulator / Test	Polystyrene	Fibreglass
1	25%	25-3%
2	24-3%	23.9
3	25-1%	26-2%

Graph Percentage of heat insulated by the insulators

5



Conclusion Fibreglass is a slightly better insulator the Polystyrene

Report

Expol is an underfloor insulation product made from polystyrene. It is used to stop heat entering in summer and escaping in winter. Expol insulation has excellent thermal properties as it is mainly consisted of stabilised air. Expol is non-allergenic, contains a flame retardent, its thermal performance is not affected by ageing and contains no CFC's.

Fibreglass (Pinkbatts) is one of the most popular forms of home insulation. It's inexpensive, simple to install and has high R-Values. Fibreglass works because still air is an extremely poor conductor of heat. The air is trapped between the finely spun particles of glass fibre, in mats or biscuit form. The resulting pockets of air are very effective at keeping the wasth in and cold out of the home.

The R-value is a measure of thermal resistance. To find out the R-value this equation is used: $R = \Delta T / \dot{Q}_A$. The higher the R-value the better the insulator.

Heat is the process of energy transfer from one body or system due to thermal contact. Energy transfer by heat can occur between objects by radiation, conduction and convection. Conduction is the transfer of energy through matter from one particle to another. Convection is the transfer of heat energy in a gas or liquid by movement of currents. Radiation is the transfer of heat energy though electromagnetic waves that directly transm energy through space.

Overall fibreglass is better than Expol. Fibreglass has more positive advantages than Expol. Fibreglass is cheap, high R-values and prevents convection because there is no currents flowing through the air gaps. It also decreases the amount of heat escaping through conduction because there are less particles for the heat to transfe through It doesn't prevent radiation heat loss as well as expol because it doesn't have a good reflective surface. Because of the high R-value it has good thermal resistance which keeps heat in, in winter and out in summer.

5

Expol is a good insulator but fibreglass is better because in my experiment fibreglass kept less air out than Expol but kept more air in than Expool so your floors would be warmer with fibreglass than with Expol's polystyrene

Expol

5

Expol Under Floor Insulation is the way to insulate your existing home to stop heat entering in summer and escaping in winter.

Expol Insulation Panels are designed to be self supporting and easy to install.

Placed snugly between the floor joists to ensure your home is protected from the extreme temperatures under your floor.

Great for polished floors in bungalows and villas
Save around 12% on your heating bills
Expol Insulation has excellent thermal properties as it consists mainly of stabilised air

Expol Insulation is safe to install, non-allergenic, contains a flame retardant. Its thermal performance is not affected by ageing, and contains no CFC's.

Expol under-floor insulation is available in easy to handle panels:
1200 x 360 x 60mm
1200 x 410 x 60mm
1200 x 470 x 60mm
1200 x 560 x 60mm

Expol Insulation incorporates FLEXICUT
- a unique system provided for simple installation!
Easy to cut with a sharp knife. Spring into place, cut or break off to ensure a snug fit in walls, ceilings and under floors.

5

Fibreglass is one of the most popular forms of home insulation. It's relatively inexpensive, simple to install and has high R-Values. It's also known as mineral wool or glass wool.

How it works

Still air is an extremely poor conductor of heat. Fibreglass insulation works by trapping air between finely spun particles of glass fibre, in mats or biscuit form. The resulting pocket of air is very effective at keeping warmth in and cold out of the home.

How it's made

Recycled glass is heated to extremely high temperatures and spun into fibres, which are then densely layered into mats or batting.

Why it's good

- Inexpensive compared to wool or loose fill insulation
- High R-Values
- Easy to install
- Widely available
- Special varieties for acoustic soundproofing and wet areas

Is it safe?

Particles can irritate the skin. If you are installing fibreglass insulation yourself you need to take care with installation. Right House recommends a professional undertake the installation of your insulation.

How much will it cost?

The cost of insulation will depend on the R-Value (level) of insulation required. The higher the R-Value the higher the cost, but the greater the benefit.

The maximum R-Value for walls is R2.8 (in a 90mm wall) whereas in ceilings insulation can be up to R5 and underfloor up to R3.2 (depending on the space and insulation used).

Heat

5

In physics and thermodynamics, **heat** is the process of energy transfer from one body or system due to thermal contact, which in turn is defined as an energy transfer to a body in any other way than due to work performed on the body.[1]

A related term is thermal energy, loosely defined as the energy of a body that increases with its temperature. Heat is also loosely referred to as thermal energy, although many definitions require this thermal energy to actually be in the process of movement between one body and another to be technically called *heat* (otherwise, many sources prefer to continue to refer to the static quantity as "thermal energy"). Heat is a form of Energy, but energy is not necessarily heat[citation needed].

Energy transfer by heat can occur between objects by radiation, conduction and convection. Temperature is used as a measure of the internal energy or enthalpy, that is the level of elementary motion giving rise to heat transfer. Energy can only be transferred by heat between objects - or areas within an object - with different temperatures (as given by the zeroth law of thermodynamics). This transfer happens spontaneously only in the direction of the colder body (as per the second law of thermodynamics). The transfer of energy by heat from one object to another object with an equal or higher temperature can happen only with the aid of a heat pump via mechanical work.

The **R value** or **R-value** is a measure of thermal resistance [1] used in the building and construction industry. Under uniform conditions it is the ratio of the temperature difference across an insulator and the heat flux (heat flow per unit area, $\dot{Q}_A$) through it or $R = \Delta T / \dot{Q}_A$. The bigger the number, the better the building insulation's effectiveness[2]. R-value is the reciprocal of U-value.

	Grade Boundary: High Not Achieved
6.	Investigation not completed. Data given but no processing. Report based on the data but with no other means of showing how this material was researched. It is an N. Could not explain the difference between the types of insulation.

6

Control: Starting temp : 20°C
Ending temp 28°C Av.
TEST 2 Start temp 20°C 7.5
End temp 27°C

Fibreglass: Start temp 19°C Av.
End temp 20°C 0.75
TEST 2 Start temp 20°C
End temp 20.5°C

Polystyrene: Start temp 19°C Av.
End temp 20°C 1.
TEST 2 Start temp 20.°C
End temp 21°C.

Fibreglass vs Polystyrene.

6

For the same thickness, Fibreglass turned out to be the better insulator according to the tests carried out. The average temperature lost when there was no insulation was 7.5°C, when Fibreglass was used was 0.75°C and 1°C was lost when polystyrene was used.

Both insulating materials work in the same way, by trapping air between the fine particles of glass fibres and plastic. The resulting air pockets are very effective at keeping the warmth in and the cold out. As the still air pockets are poor conductors of heat which slows the speed of the heat transference. So as both of the insulators work in the same way: trapping the air, they should both theoretically prevent the same amount of heat loss, which they both did, having a 0.25°C temperature difference. Though these results may have differed had the insulation been under the heat source as it is meant to be, as it is underfloor insulation. It also may have made a difference if the insulation was right up to the heat source (no air gap) as approximately 12-20°C of heat can escape from a home if the insulation is not properly insulated (there is a gap between the floorboards and the insulation).